

National Child and Maternal Health Education Program

Selected Abstracts on Late Preterm Birth Outcomes

1. *Pediatr Clin North Am.* 2009 Jun;56(3):565-77, Table of Contents.

Health issues of the late preterm infant.

Ramachandrappa A, Jain L.

Department of Pediatrics, Division of Neonatology, Emory University School of Medicine, Atlanta, GA 30322, USA. ashwin_ramachandrappa@oz.ped.emory.edu

"Late preterm" birth is not such an unusual occurrence; in fact these infants were the first group of premature infants who pediatricians learned to treat, and did so with such remarkable success that physicians no longer consider them to be of high risk. So, why the sudden interest in this group? There is now enough evidence that this population is not as benign as previously thought. They have increased mortality when compared to term infants and are at increased risk for complications including transient tachypnea of newborn (TTN), respiratory distress syndrome (RDS), persistent pulmonary hypertension (PPHN), respiratory failure, temperature instability, jaundice, feeding difficulties and prolonged neonatal intensive care unit (NICU) stay. Evidence is currently emerging that late preterm infants make up a majority of preterm births, take up significant resources, have increased mortality/morbidity, and may even have long-term neurodevelopmental consequences secondary to their late prematurity.

PMID: 19501692 [PubMed - indexed for MEDLINE]

2. *MCN Am J Matern Child Nurs.* 2008 Sep-Oct;33(5):287-93.

Late preterm birth: a new nursing issue.

Shaw RR.

INOVA Alexandria Hospital, Alexandria, VA, USA. rariesser@gmail.com

Late preterm infants are those born between 34 and 36 6/7 completed weeks' gestation. In the last decade, late preterm infants have become the fastest growing subset of preterm infants and now account for 74% of all preterm births. They are at greater risk for feeding problems, dehydration, hypothermia, jaundice, and hypoglycemia and are more likely to be readmitted to the hospital in the first weeks after birth and accrue greater healthcare costs as a result. Despite the alarming growth of this population and the acknowledgment of increased risk in the literature, there is limited information available to the clinical nurse and few evidence-based guidelines to direct the care of these

infants specifically. This article describes what is known to date about this issue and what nurses need to do to appropriately care for late preterm infants.

PMID: 18758331 [PubMed - indexed for MEDLINE]

3. Crit Care Nurs Clin North Am. 2009 Jun;21(2):149-61.

So, he's a little premature...what's the big deal?

Verklan MT.

University of Texas Health Science Center, School of Nursing, 6901 Bertner Avenue, Suite 565, Houston, TX 77459, USA. m.t.verklan@uth.tmc.edu

Health care providers have recently recognized that a large segment of the morbidity associated with preterm birth is disproportionately due to the late preterm infant (LPI). One explanation is that this population is the fastest-growing sector of all preterm births. This article describes the epidemiology and etiology of the LPI, and discusses why the LPI is at an increased risk for complications, such as thermal instability, hypoglycemia, feeding difficulties, respiratory distress, hyperbilirubinemia, and sepsis. The need for emergency department visits after hospital discharge and what is currently known regarding neurodevelopmental outcomes are also presented.

PMID: 19460661 [PubMed - indexed for MEDLINE]

4. Obstet Gynecol. 2008 Jan;111(1):35-41.

Neonatal mortality and morbidity rates in late preterm births compared with births at term.

McIntire DD, Leveno KJ.

Department of Obstetrics and Gynecology, The University of Texas Southwestern Medical Center, Dallas, Texas 75235-9032, USA. donald.mcintire@utsouthwestern.edu

OBJECTIVE: To analyze neonatal mortality and morbidity rates at 34, 35, and 36 weeks of gestation compared with births at term over the past 18 years at our hospital and to estimate the magnitude of increased risk associated with late preterm births compared with births later in gestation. **METHODS:** We performed a retrospective cohort study of births at our hospital over the past 18 years. The study included all liveborn singleton infants between 34 and 40 weeks of gestation and without anomalies that were delivered to women who received prenatal care in our hospital system. Neonatal outcomes for late preterm births were compared with those for infants delivered at 39 weeks. **RESULTS:** Late preterm singleton live births constituted approximately 9% of all deliveries at our

hospital and accounted for 76% of all preterm births. Late preterm neonatal mortality rates per 1,000 live births were 1.1, 1.5, and 0.5 at 34, 35, and 36 weeks, respectively, compared with 0.2 at 39 weeks ($P<.001$). Neonatal morbidity was significantly increased at 34, 35, and 36 weeks, including ventilator-treated respiratory distress, transient tachypnea, grades 1 or 2 intraventricular hemorrhage, sepsis work-ups, culture-proven sepsis, phototherapy for hyperbilirubinemia, and intubation in the delivery room. Approximately 80% of late preterm births were attributed to idiopathic preterm labor or ruptured membranes and 20% to obstetric complications. **CONCLUSION:** Late preterm births are common and associated with significantly increased neonatal mortality and morbidity compared with births at 39 weeks. Preterm labor was the most common cause (45%) for late preterm births. **LEVEL OF EVIDENCE:** II.

PMID: 18165390 [PubMed - indexed for MEDLINE]

5. Semin Perinatol. 2006 Apr;30(2):54-60.

Risk factors for neonatal morbidity and mortality among "healthy," late preterm newborns.

Shapiro-Mendoza CK, Tomashek KM, Kotelchuck M, Barfield W, Weiss J, Evans S.

Centers for Disease Control and Prevention, Division of Reproductive Health, Maternal and Infant Health Branch, Atlanta, GA 30341, USA. ayn9@cdc.gov

Research about neonatal outcomes among late preterm infants (34 weeks through 36 6/7 weeks of gestation) is limited. Understanding which late preterm infants are at risk for neonatal morbidity or mortality is necessary to improve health outcomes and reduce hospital costs. We conducted a population-based cohort study of "healthy," singleton late preterm infants vaginally delivered in Massachusetts hospitals to Massachusetts residents between 1998 and 2002. We compared the incidence of neonatal morbidity (postdelivery inpatient readmissions, observational stays, or mortality) between "healthy," late preterm infants with and without infant, obstetric, and sociodemographic factors by calculating risk ratios adjusted for confounding. Of the 9552 late preterm, "healthy" infants, 4.8% had an inpatient readmission and 1.3% had an observational stay. Infants with neonatal morbidity were more likely to be firstborn, be breastfed at discharge, have labor and delivery complications, be a recipient of a public payer source at delivery, or have an Asian/Pacific Islander mother. Non-Hispanic blacks had a decreased risk for neonatal morbidity compared to other racial/ethnic groups. Knowledge of risk factors for neonatal morbidity among "healthy" late preterm infants can be used to identify infants needing closer monitoring and earlier follow-up after hospital discharge.

PMID: 16731277 [PubMed - indexed for MEDLINE]

6. Pediatrics. 2008 Feb;121(2):e223-32.

Effect of late-preterm birth and maternal medical conditions on newborn morbidity risk.

Shapiro-Mendoza CK, Tomashek KM, Kotelchuck M, Barfield W, Nannini A, Weiss J, Declercq E.

Division of Reproductive Health, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention, Atlanta, Georgia 30341-3717, USA. ayn9@cdc.gov

Comment in:

Pediatrics. 2008 Feb;121(2):402-3.

OBJECTIVES: Late-preterm infants (34-36 weeks' gestation) account for nearly three quarters of all preterm births in the United States, yet little is known about their morbidity risk. We compared late-preterm and term (37-41 weeks' gestation) infants with and without selected maternal medical conditions and assessed the independent and joint effects of these exposures on newborn morbidity risk. **METHODS:** We used 1998-2003, population-based, Massachusetts birth and death certificates data linked to infant and maternal hospital discharge records from the Massachusetts Pregnancy to Early Life Longitudinal data system. Newborn morbidity risks that were associated with gestational age and selected maternal medical conditions, both independently and as joint exposures, were estimated by calculating adjusted risk ratios. A new measure of newborn morbidity that was based on hospital discharge diagnostic codes, hospitalization duration, and transfer status was created to define newborns with and without life-threatening conditions. Eight selected maternal medical conditions were assessed (hypertensive disorders of pregnancy, diabetes, antepartum hemorrhage, lung disease, infection, cardiac disease, renal disease, and genital herpes) in relation to newborn morbidity. **RESULTS:** Our final study population included 26,170 infants born late preterm and 377,638 born at term. Late-preterm infants were 7 times more likely to have newborn morbidity than term infants (22% vs 3%). The newborn morbidity rate doubled in infants for each gestational week earlier than 38 weeks. Late-preterm infants who were born to mothers with any of the maternal conditions assessed were at higher risk for newborn morbidity compared with similarly exposed term infants. Late-preterm infants who were exposed to antepartum hemorrhage and hypertensive disorders of pregnancy were especially vulnerable. **CONCLUSIONS:** Late-preterm birth and, to a lesser extent, maternal medical conditions are each independent risk factors for newborn morbidity. Combined, these 2 factors greatly increased the risk for newborn morbidity compared with term infants who were born without exposure to these risks.

PMID: 18245397 [PubMed - indexed for MEDLINE]

7. Pediatrics. 2007 Apr;119(4):e866-74. Epub 2007 Mar 5.

Preterm birth-associated cost of early intervention services: an analysis by gestational age.

Clements KM, Barfield WD, Ayadi MF, Wilber N.

Massachusetts Department of Public Health, Center for Community Health, 250 Washington St, 5th Floor, Boston, MA 02108, USA. karen.clements@state.ma.us

OBJECTIVES: Characterizing the cost of preterm birth is important in assessing the impact of increasing prematurity rates and evaluating the cost-effectiveness of therapies to prevent preterm delivery. To assess early intervention costs that are associated with preterm births, we estimated the program cost of early intervention services for children who were born in Massachusetts, by gestational age at birth. **METHODS:** Using the Pregnancy to Early Life Longitudinal Data Set, birth certificates for infants who were born in Massachusetts between July 1999 and June 2000 were linked to early intervention claims through 2003. We determined total program costs, in 2003 dollars, of early intervention and mean cost per surviving infant by gestational age. Costs by plurality, eligibility criteria, provider discipline, and annual costs for children's first 3 years also were examined. **RESULTS:** Overall, 14,033 of 76,901 surviving infants received early intervention services. Program costs totaled almost \$66 million, with mean cost per surviving infant of \$857. Mean cost per infant was highest for children who were 24 to 31 weeks' gestational age (\$5393) and higher for infants who were 32 to 36 weeks' gestational age (\$1578) compared with those who were born at term (\$725). Cost per surviving infant generally decreased with increasing gestational age. Among children in early intervention, mean cost per child was higher for preterm infants than for term infants. At each gestational age, mean cost per surviving infant was higher for multiples than for singletons, and annual early intervention costs were higher for toddlers than for infants. **CONCLUSIONS:** Compared with their term counterparts, preterm infants incurred higher early intervention costs. This information along with data on birth trends will inform budget forecasting for early intervention programs. Costs that are associated with early childhood developmental services must be included when considering the long-term costs of prematurity.

PMID: 17339387 [PubMed - indexed for MEDLINE]

8. Nurs Womens Health. 2008 Aug;12(4):316-30; quiz 330-1.

Late preterm infants: clinical complications and risk: part two of a two-part series.

Jorgensen AM.

Good Samaritan Hospital in Suffern, NY, USA. neostarconsult@aol.com

Comment in:

Nurs Womens Health. 2009 Feb;13(1):11-2; author reply 12.

PMID: 18715379 [PubMed - indexed for MEDLINE]

9. J Perinatol. 2009 May;29 Suppl 2:S12-7.

Late preterm infants: severe hyperbilirubinemia and postnatal glucose homeostasis.

Adamkin DH.

Department of Pediatrics, University of Louisville School of Medicine, Louisville, KY 40202, USA. ulneomed@louisville.edu

The identification of late preterm infants as a high-risk group of infants has been an important public health breakthrough. These infants have suffered a relative 'silent morbidity and mortality' before the recognition that they have unique physiology and risks. These infants represent almost three-fourths of all premature births in the United States. Many of these infants, because of their birthweight and appearance, have been treated in Well Baby Nurseries and even discharged by 48 h of birth despite specific unidentified or unappreciated risks that have led to their readmission and possible severe morbidities or even death. Two common problems for these infants include neonatal hypoglycemia and severe hyperbilirubinemia. The definition of hypoglycemia remains controversial but is nonetheless a problem of increasing frequency in these infants.

PMID: 19399003 [PubMed - indexed for MEDLINE]

10. Semin Perinatol. 2006 Apr;30(2):73-6.

Ontogeny of autonomic regulation in late preterm infants born at 34-37 weeks postmenstrual age.

Hunt CE.

Uniformed Services University of the Health Sciences, Bethesda, MD 20892, USA.
huntc@nhlbi.nih.gov

Late preterm infants (34-37 weeks postmenstrual age at birth) are intermediate between less mature preterm infants and infants born at 38 weeks or more in regard to autonomic brain stem maturation. Ventilatory responses to CO₂ in preterm infants born at 33 to 36 week are significantly higher than in infants born at 29 to 32 weeks both at 3 to 4 and 10 to 14 days postnatal age, but do not differ from full-term reference levels. The ventilatory response to hypoxia in preterm infants is biphasic; initial transient hyperventilation is followed by a return to baseline and then a decrease below baseline. In infants born at 32 to 37 weeks, parasympathetic maturation appears significantly less than in full-term infants based on diminished increases in high frequency heart rate variability in quiet sleep, suggesting that late preterm infants are still more susceptible to bradycardia than full-term infants. Both the presence and severity of apnea of prematurity progressively decrease the higher the postmenstrual age. Late preterm infants, however, are still at risk, with prevalence rates as high as 10% compared with about 60% in infants born at <1500 g. The incidence of apparent life-threatening events is more common in preterm infants (8-10%) than full-term infants (1% or less). In the Collaborative Home Infant Monitoring Evaluation studies, the frequency of conventional and extreme events in near term infants is intermediate between preterm infants <34 weeks at birth and full-term infants. The relative risk for at least one extreme event in late preterm infants is increased (5.6 and 7.6, respectively, $P < 0.008$) compared with full-term infants and remains higher until 43 weeks postmenstrual age. The rate for Sudden Infant Death Syndrome in preterm infants born at 33 to 36 weeks is 1.37/1000 live births compared with 0.69 in infants born full term. Affected late preterm infants die at a older mean postmenstrual age compared with less mature infants (48 and 46 weeks, respectively), but die at a younger postmenstrual age than full-term infants (53 weeks, $P < 0.05$).

PMID: 16731280 [PubMed - indexed for MEDLINE]

11. Paediatr Perinat Epidemiol. 2008 Jul;22(4):350-9.

Associated factors and consequences of late preterm births: results from the 2004 Pelotas birth cohort.

Santos IS, Matijasevich A, Silveira MF, Sclowitz IK, Barros AJ, Victora CG, Barros FC.

Pós-graduação em Epidemiologia, Universidade Federal de Pelotas (UFPel), Pelotas, Brazil. inasantos@uol.com.br

Although neonatal and infant mortality rates have fallen in recent decades in Brazil, the prevalence of preterm deliveries has increased in certain regions, especially in the number of late preterm births. This study was planned to investigate: (1) maternal antenatal characteristics associated with late preterm births and (2) the consequences of late preterm birth on infant health in the neonatal period and until age 3 months. A population-based birth cohort was enrolled in Pelotas, Southern Brazil, in 2004. Mothers were interviewed and the gestational age of newborns was estimated through last menstrual period, ultrasound and Dubowitz's method. Preterm births between 34 and 36 completed weeks of gestational age were classified as late preterm births. Only singleton live births from mothers living in the urban area of Pelotas were investigated. Three months after birth, mothers were interviewed at home regarding breast feeding, morbidity and hospital admissions. All deaths occurring in the first year of life were recorded. A total of 447 newborns (10.8%) were late preterms. Associations were observed with maternal age <20 years (prevalence ratio [PR] 1.3 [95% CI 1.1, 1.6]), absence of antenatal care (PR 2.4 [1.4, 4.2]) or less than seven prenatal care visits, arterial hypertension (PR 1.3 [1.0, 1.5]), and preterm labour (PR 1.6 [1.3, 1.9]). Compared with term births, late preterm births showed increased risk of depression at birth (Relative risk [RR] 1.7 [1.3, 2.2]), perinatal morbidity (RR 2.8 [2.3, 3.5]), and absence of breast feeding in the first hours after birth (PR 0.9 [0.8, 0.9]). RRs for neonatal and infant mortality were, respectively, 5.1 [1.7, 14.9] and 2.1 [1.0, 4.6] times higher than that observed among term newborns. In conclusion, in our setting, the prevention of all preterm births must be a priority, regardless of whether early or late.

PMID: 18578748 [PubMed - indexed for MEDLINE]

12. Am J Obstet Gynecol. 2009 May;200(5):e30-3. Epub 2009 Jan 10.

Indications for delivery and short-term neonatal outcomes in late preterm as compared with term births.

Lubow JM, How HY, Habli M, Maxwell R, Sibai BM.

Department of Obstetrics and Gynecology, Division of Maternal-Fetal Medicine, University of Cincinnati College of Medicine, Cincinnati, OH, USA.

OBJECTIVE: The objective of the study was to evaluate the indications for late preterm birth and compare outcomes by gestational age among late preterm (34-36 weeks) and term (> or = 37 weeks) neonates at our institution. **STUDY DESIGN:** This was a retrospective analysis of delivery indications and short-term neonatal outcomes in women who delivered at the University Hospital between January 1,

2005 and Dec. 31, 2006. Data were analyzed using chi(2), Student's t-test, analysis of variance, and post hoc Tukey tests. RESULTS: One hundred forty-nine late preterm (n = 49 for 34, n = 50 for 35, n = 50 for 36 weeks) and 150 term infants (n = 50 for 37, n = 50 for 38, n = 50 for 39 weeks or longer) were evaluated. Differences among groups (ie, 34 vs 35 vs 36 vs 37, etc) as well as combinations of differences between 2 groups (ie, 34-36 weeks vs > or = 37 or > or = 38 weeks) were analyzed. Spontaneous labor and/or rupture of membranes were the most common indications for late preterm delivery (92%). Compared with term, late preterm infants had longer hospital stays (5 days vs 2.4 days; P < .001) and higher rates of neonatal intensive care unit (NICU) admissions (56% vs 4%; P < .001), feeding problems (36% vs 5%; P < .001), hyperbilirubinemia (25% vs 3%; P < .001), and respiratory complications (20% vs 5%; P < .001). Neonatal complications were minimal at 38 weeks or longer. CONCLUSION: Rates of neonatal intensive care unit admission, length of stay, and neonatal morbidities are significantly higher in late preterm as compared with term births.

PMID: 19136092 [PubMed - indexed for MEDLINE]

13. Semin Perinatol. 2006 Apr;30(2):89-97.

Kernicterus in late preterm infants cared for as term healthy infants.

Bhutani VK, Johnson L.

Department of Neonatal and Developmental Medicine, Lucile Salter Packard Children's Hospital, Stanford University, Palo Alto, CA 94305, USA.
bhutani@stanford.edu

OBJECTIVE: To compare the clinical profile and health care experiences related to management of newborn jaundice and hyperbilirubinemia in preterm infants (<37(0/7) weeks gestation) who are cared for as term infants (> or =37(0/7) weeks) and develop acute and/or chronic posticteric sequelae. METHODS: Retrospective study of a convenient sample of term and near term infants voluntarily reported to the Pilot Kernicterus Registry (1992-2003). Study infants were required to meet the clinical definitions for acute bilirubin encephalopathy (moderate or advanced severity) and/or the classical signs of kernicterus. Main outcome measures were the comparison of etiology, severity and duration of extreme hyperbilirubinemia (TSB levels >20 mg/dL), response to interventions of intensive phototherapy and exchange transfusion, and health care delivery experiences in preterm as compared with term infants. RESULTS: No targeted attention was accorded to preterm infants during their neonatal health care experiences as related to predischarge risk assessment, feeding, discharge follow-up instructions, or breastfeeding, regardless of the known vulnerability of preterm infants to safely transition during the first week after birth. The TSB levels, age at re-hospitalization, and birth weight distribution were similar for late preterm and term infants. Large for gestational age and late preterm infants disproportionately developed kernicterus as compared with those who were

appropriate for gestational age and term. Clinical management of extreme of hyperbilirubinemia, by the attending clinical providers, was not impacted or influenced by the gestational age, clinical signs, or risk assessment. This resulted in severe posticteric sequelae which was more severe and frequent in late preterm infants. CONCLUSIONS: Late prematurity (34(0/7) to 36(6/7) weeks) of healthy infants was not recognized as a risk factor for hazardous hyperbilirubinemia by clinical practitioners. Unsuccessful lactation experience was the most frequent experience; being large for gestational age as well as the other known biologic risk factors for hyperbilirubinemia and bilirubin neurotoxicity were not identified by the clinical care providers either before discharge or at immediate postdischarge follow up.

PMID: 16731283 [PubMed - indexed for MEDLINE]

14. JAMA. 2000 Aug 16;284(7):843-9.

The contribution of mild and moderate preterm birth to infant mortality. Fetal and Infant Health Study Group of the Canadian Perinatal Surveillance System.

Kramer MS, Demissie K, Yang H, Platt RW, Sauvé R, Liston R.

1020 Pine Ave W, Montreal, Quebec, Canada H3A 1A2. mkrame@po-box.mcgill.ca

CONTEXT: The World Health Organization defines preterm birth as birth at less than 37 completed gestational weeks, but most studies have focused on very preterm infants (birth at <32 weeks) because of their high risk of mortality and serious morbidity. However, infants born at 32 through 36 weeks are more common and their public health impact has not been well studied. OBJECTIVE: To assess the quantitative contribution of mild (birth at 34-36 gestational weeks) and moderate (birth at 32-33 gestational weeks) preterm birth to infant mortality. DESIGN, SETTING, AND PARTICIPANTS: Population-based cohort study using linked singleton live birth-infant death cohort files for US birth cohorts for 1985 and 1995 and Canadian birth cohorts (excluding Ontario) for 1985-1987 and 1992-1994. MAIN OUTCOME MEASURES: Relative risks (RRs) and etiologic fractions (EFs) for overall and cause-specific early neonatal (age 0-6 days), late neonatal (age 7-27 days), postneonatal (age 28-364 days), and total infant death among mild and moderate preterm births vs term births (at ≥ 37 gestational weeks). RESULTS: Relative risks for infant death from all causes among singletons born at 32 through 33 gestational weeks were 6.6 (95% confidence interval [CI], 6.1-7.0) in the United States in 1995 and 15.2 (95% CI, 13.2-17.5) in Canada in 1992-1994; among singletons born at 34 through 36 gestational weeks, the RRs were 2.9 (95% CI, 2.8-3.0) and 4.5 (95% CI, 4.0-5.0), respectively. Corresponding EFs were 3.2% and 4.8%, respectively, at 32 through 33 gestational weeks and 6.3% and 8.0%, respectively, at 34 through 36 gestational weeks; the sum of the EFs for births at 32 through 33 and 34 through 36 gestational weeks exceeded those for births at 28 through 31 gestational weeks. Substantial RRs were observed overall for the neonatal (eg, for early neonatal deaths, 14.6 and 33.0 for US and Canadian

infants, respectively, born at 32-33 gestational weeks; EFs, 3.6% and 6.2% for US and Canadian infants, respectively) and postneonatal (RRs, 2.1-3.8 and 3.0-7.0 for US and Canadian infants, respectively, born at 32-36 gestational weeks; EFs, 2.7%-5.8% and 3.0%-7.0% for the same groups, respectively) periods and for death due to asphyxia, infection, sudden infant death syndrome, and external causes. Except for a reduction in the RR and EF for neonatal mortality due to infection, the patterns have changed little since 1985 in either country. CONCLUSIONS: Mild- and moderate-preterm birth infants are at high RR for death during infancy and are responsible for an important fraction of infant deaths. JAMA. 2000;284:843-849

PMID: 10938173 [PubMed - indexed for MEDLINE]

15. J Perinat Neonatal Nurs. 2009 Jan-Mar;23(1):78-86.

Complications of the late preterm infant.

Darcy AE.

University of Pennsylvania School of Nursing, Philadelphia, PA 19104, USA.
ashleye@nursing.upenn.edu

One of the goals of Healthy People 2010 (set in 1998) was to reduce preterm birthrates from 11.6% to 7.6%. However, in 2004, the preterm birthrate of 12.5% was actually higher than the rate in 1998. Approximately 65% of this increase in prematurity rate is attributed to the increasing birthrate of the late preterm infant. Care of the late preterm infant is far more complicated than many hospital policies and clinical guidelines imply. It cannot be stressed enough to frontline clinicians that late preterm infants are not full-term infants. Their care should not be defined by the same policies and practices that govern term infants. The purpose of this article is to explore the complications that accompany late preterm birth. The following complications will be discussed: thermoregulation challenges, feeding difficulty, late neonatal sepsis, prolonged physiologic jaundice, hypoglycemia, possible neurodevelopmental differences, and respiratory problems.

PMID: 19209064 [PubMed - indexed for MEDLINE]

16. Lancet. 2008 Jan 19;371(9608):261-9.

An overview of mortality and sequelae of preterm birth from infancy to adulthood.

Saigal S, Doyle LW.

Department of Paediatrics, McMaster University, Hamilton, ON, Canada.
saigal@mcmaster.ca

Comment in:

Lancet. 2008 Mar 15;371(9616):897-8.

Survival rates have greatly improved in recent years for infants of borderline viability; however, these infants remain at risk of developing a wide array of complications, not only in the neonatal unit, but also in the long term. Morbidity is inversely related to gestational age; however, there is no gestational age, including term, that is wholly exempt. Neurodevelopmental disabilities and recurrent health problems take a toll in early childhood. Subsequently hidden disabilities such as school difficulties and behavioural problems become apparent and persist into adolescence. Reassuringly, however, most children born very preterm adjust remarkably well during their transition into adulthood. Because mortality rates have fallen, the focus for perinatal interventions is to develop strategies to reduce long-term morbidity, especially the prevention of brain injury and abnormal brain development. In addition, follow-up to middle age and beyond is warranted to identify the risks, especially for cardiovascular and metabolic disorders that are likely to be experienced by preterm survivors.

PMID: 18207020 [PubMed - indexed for MEDLINE]

17. J Pediatr. 2007 Nov;151(5):450-6, 456.e1. Epub 2007 Jul 24.

Differences in mortality between late-preterm and term singleton infants in the United States, 1995-2002.

Tomashek KM, Shapiro-Mendoza CK, Davidoff MJ, Petrini JR.

Maternal and Infant Health Branch, Division of Reproductive Health, Centers for Disease Control and Prevention, Atlanta, Georgia, USA. kct9@cdc.gov

Comment in:

J Pediatr. 2007 Nov;151(5):445-6.

OBJECTIVE: To assess differences in mortality between late-preterm (34-36 weeks) and term (37-41 weeks) infants. **STUDY DESIGN:** We used US period-linked birth/infant death files for 1995 to 2002 to compare overall and cause-specific early-neonatal, late-neonatal, postneonatal, and infant mortality rates between singleton late-preterm infants and term infants. **RESULTS:** Significant declines in mortality rates were observed for late-preterm and term infants at all age-at-death categories, except the late-neonatal period. Despite the decline in rates since 1995, infant mortality rates in 2002 were 3 times higher in late-preterm infants than term infants (7.9 versus 2.4 deaths per 1000 live births); early, late, and postneonatal rates were 6, 3, and 2 times higher, respectively. During infancy, late-preterm infants were approximately 4 times more likely than term infants to die of congenital malformations (leading cause),

newborn bacterial sepsis, and complications of placenta, cord, and membranes. Early-neonatal cause-specific mortality rates were most disparate, especially deaths caused by atelectasis, maternal complications of pregnancy, and congenital malformations. CONCLUSIONS: Late-preterm infants have higher mortality rates than term infants throughout infancy. Our findings may be used to guide obstetrical and pediatric decision-making.

PMID: 17961684 [PubMed - indexed for MEDLINE]

18. Pediatrics. 2009 Jun;123(6):e1064-71.

Incidence of early neonatal mortality and morbidity after late-preterm and term cesarean delivery.

De Luca R, Boulvain M, Irion O, Berner M, Pfister RE.

Neonatal Intensive Care Unit, Department of Pediatrics, University Hospital Geneva, 1211 Geneva 14, Switzerland.

OBJECTIVE: To determine the age-stratified risk of intrapartum and neonatal mortality as well as morbidities of clinical relevance after elective cesarean delivery (ECD). METHODS: This work was a cohort study including 56 549 prospectively recorded late-preterm and term deliveries. We analyzed the effect of cesarean delivery (CD) before the onset of labor on the following multiple neonatal outcomes before hospital discharge, compared with planned vaginal delivery (PVD) and emergency CD: mortality, birth depression, special care admission, and respiratory morbidity. We adjusted for confounders by multivariate analysis and stratified the risk according to gestational age (GA). RESULTS: Mortality and morbidities had a strong GA-related trend with the lowest incidences consistently found between 38 and 40 weeks of gestation independent of delivery mode. Compared with infants delivered via PVD, infants delivered via ECD had significantly higher rates of mortality (adjusted risk ratio [aRR]: 2.1), risk of special care admission (aRR: 1.4), and respiratory morbidity (aRR: 1.8) but not of depression at birth (aRR: 1.1). Compared with emergency CD, newborns delivered via ECD had less depression at birth (aRR: 0.6) and admission to special care (aRR: 0.8), but mortality (aRR: 0.8) and respiratory morbidity (aRR: 1.0) rates were similar. CONCLUSIONS: Gestational age-specific risk estimates are lowest between 38 and 40 weeks and should be included in the informed-consent process. The information should also be used to allow for appropriate preparation with respect to adequate staff and equipment. ECD is consistently associated with increased intrapartum and neonatal mortality, risk of admission, and respiratory morbidity compared with PVD and has no advantage over emergency CD in terms of mortality. Neonatal morbidities are lower after ECD than emergency CD only with term births. Our data provide evidence that ECD should not be performed before term.

PMID: 19482739 [PubMed - indexed for MEDLINE]

19. Semin Perinatol. 2006 Feb;30(1):28-33.

Short-term outcomes of infants born at 35 and 36 weeks gestation: we need to ask more questions.

Escobar GJ, Clark RH, Greene JD.

Division of Research, Perinatal Research Unit, Kaiser Permanente Medical Care Program, Oakland, CA 94612, USA. gabriel.escobar@kp.org

BACKGROUND: Newborns who are 35 to 36 weeks gestation comprise 7.0% of all live births and 58.3% of all premature infants in the United States. They have been studied much less than very low birth weight infants. **OBJECTIVE:** To examine available data permitting quantification of short-term hospital outcomes among infants born at 35 and 36 weeks gestation. **DESIGN:** Review of existing published data and, where possible, re-analysis of existing databases or retrospective cohort analyses. **SETTING:** Multiple hospitals and neonatal intensive care units in the United States and England. **PATIENTS:** Premature infant cohorts with infants whose dates of birth ranged from 1/1/98 through 6/30/04. **MAIN OUTCOME MEASURES:** 1) Death, 2) respiratory distress requiring some degree of in-hospital respiratory support during the birth hospitalization, and 3) rehospitalization following discharge home after the birth hospitalization. **RESULTS:** Newborns born at 35 and 36 weeks gestation experienced considerable mortality and morbidity. Approximately 8% required supplemental oxygen support for at least 1 hour, almost 3 times the rate found in infants born at ≥ 37 weeks. Among 35 to 36 week newborns who progressed to respiratory failure and who survived to 6 hours of age and did not have major congenital anomalies, the mortality rate was 0.8%. Following discharge from the birth hospitalization, 35 to 36 week infants were much more likely to be rehospitalized than term infants, and this increase was evident both within 14 days as well as within 15 to 182 days after discharge. In addition, late preterm infants experienced multiple therapies, few of which have been formally evaluated for safety or efficacy in this gestational age group. **CONCLUSIONS:** Greater attention needs to be paid to the management of late preterm infants. In addition, it is important to conduct formal evaluations of the therapies and follow-up strategies employed in caring for these infants.

PMID: 16549211 [PubMed - indexed for MEDLINE]

20. Pediatrics. 2007 Dec;120(6):1390-401.

"Late-preterm" infants: a population at risk.

Engle WA, Tomashek KM, Wallman C; Committee on Fetus and Newborn, American Academy of Pediatrics.

Erratum in:

Pediatrics. 2008 Feb;121(2):451.

Late-preterm infants, defined by birth at 34(0/7) through 36(6/7) weeks' gestation, are less physiologically and metabolically mature than term infants. Thus, they are at higher risk of morbidity and mortality than term infants. The purpose of this report is to define "late preterm," recommend a change in terminology from "near term" to "late preterm," present the characteristics of late-preterm infants that predispose them to a higher risk of morbidity and mortality than term infants, and propose guidelines for the evaluation and management of these infants after birth.

PMID: 18055691 [PubMed - indexed for MEDLINE]

21. J Obstet Gynecol Neonatal Nurs. 2008 Nov-Dec;37(6):692-701.

Breastfeeding the late preterm infant.

Walker M.

National Alliance for Breastfeeding Advocacy, Weston, MA, USA. marshalact@aol.com

Late preterm infants comprise the fastest growing segment of babies born prematurely. They arrive with disadvantages relative to feeding skills, stamina, and risk for conditions such as hypoglycemia, hyperbilirubinemia, and slow weight gain. Breastfeeding these babies can be difficult and frustrating. Individualized feeding plans include special considerations to compensate for immature feeding skills and inadequate breast stimulation. Breastfeeding management guidelines are described that operate within the late preterm infant's special vulnerabilities.

PMID: 19012718 [PubMed - indexed for MEDLINE]

22. J Perinat Med. 2009 Jul 10. [Epub ahead of print]

The clinical outcomes of late preterm infants: a multi-center survey of Zhejiang, China.

Ma X, Huang C, Lou S, Lv Q, Su W, Tan J, Wang Y, Wang X, Wu M, Xu T, Zhuang M, Du L; the Provincial Collaborative Study Group for Late-preterm Infants.

Children's Hospital of Zhejiang University School of Medicine, Hangzhou, Zhejiang, China.

Abstract Objective: To explore birth rate, delivery mode, medical problems, requirement of respiratory support, and acute outcomes of late preterm infants in Zhejiang province in eastern China. **Methods:** Eleven tertiary hospitals were recruited. Clinical data of every nursery admission from January to December 2007 were collected and analyzed. **Results:** During the study period, 44,362 infants

were born with an overall preterm birth rate of 8.9%, and late preterm birth rate of 6.2%. Late preterm infants had higher cesarean section rate than the whole population (64.9% vs. 58.2%). One-fifth of the nursery admissions were late preterm infants, of whom, 63.8% were delivered by cesarean section. Respiratory distress (42.1%) was the most common medical problem of late preterm infants. Hyperbilirubinemia (17.6%), hypoglycemia (8.7%) and sepsis (5.9%) were also common. The first three primary diagnoses of respiratory distress included pneumonia (39.5%), transient tachypnea of newborn (TTN) (22.5%) and respiratory distress syndrome (RDS) (19.0%). Compared with term infants, late preterm infants with respiratory distress needed more respiratory support with nasal continuous positive airway pressure (nCPAP) (21.4% vs. 11.6%) or with a mechanical ventilator (15.4% vs. 11.0%), and also had higher in-hospital mortality (0.8% vs. 0.4%). Conclusions: Late preterm infants are associated with very high cesarean section rate and have more medical problems and poorer short-term outcomes than term infants in China.

PMID: 19591555 [PubMed - as supplied by publisher]

23. Obstet Gynecol. 2008 Apr;111(4):1029-32.

ACOG committee opinion No. 404 April 2008. Late-preterm infants.

Committee on Obstetric Practice.

PMID: 18378769 [PubMed - indexed for MEDLINE]

24. Acta Paediatr. 2009 Nov;98(11):1841-3. Epub 2009 Jul 9.

Neonatal morbidity in late preterm and term infants in the nursery of a tertiary hospital.

Dani C, Corsini I, Piergentili L, Bertini G, Pratesi S, Rubaltelli FF.

Department of Surgical and Medical Critical Care, Section of Neonatology, Careggi University Hospital of Florence, Florence, Italy. cdani@unifi.it

PMID: 19604170 [PubMed - in process]

25. Pediatrics. 2007 Jul;120(1):70-7.

Preterm infants as young adults: a Swedish national cohort study.

Lindström K, Winbladh B, Haglund B, Hjern A.

Karolinska Institute, Department of Clinical Sciences and Education, Sachs

Children's Hospital, Stockholm, Sweden.

Erratum in:

Pediatrics. 2007 Oct;120(4):936.

OBJECTIVE: Increasing numbers of infants born preterm survive into adulthood. In this study, we analyzed the effect of having been born preterm on disability and vocational success in young adults. **METHODS:** A Swedish national cohort of 522,310 infants born in 1973-1979 were followed up for disabilities and income in national registers in 2002 at the age of 23 to 29. Hypotheses were tested in multivariate analysis with logistic regression models on the log scale for dichotomized outcomes and linear regression for continuous variables. **RESULTS:** There was a stepwise increase in disability in young adulthood with increasing degree of preterm birth. A total of 13.2% of children born at 24 to 28 weeks' gestation and 5.6% born at 29 to 32 weeks' gestation received economic assistance from society because of handicap or persistent illness, which is equivalent to nearly 4 [corrected] times the risk of those born at term after adjustment for socioeconomic and perinatal confounders. Moderate (33-36 weeks' gestation) and marginal (37-38 weeks' gestation) preterm birth also carried significantly increased risks for disability and were responsible for 74% of the total disability associated with preterm birth. Preterm birth was associated with a lower chance of completing a university education and a lower net salary in a stepwise manner. The total economic gain for Swedish society, in terms of taxes and decreased costs for benefits, if all long-term effects of preterm birth could have been prevented in the birth cohorts in this study, would have amounted to 65 million euros in 2002 alone. **CONCLUSIONS:** The majority of adults who were born very preterm lived an independent and self-supportive life. Moderately preterm birth carries a considerable risk for long-term impairment. There are strong economic incentives for secondary prevention of disability associated with preterm birth.

PMID: 17606563 [PubMed - indexed for MEDLINE]

26. N Engl J Med. 2008 Jul 17;359(3):262-73.

Long-term medical and social consequences of preterm birth.

Moster D, Lie RT, Markestad T.

Department of Public Health and Primary Health Care, University of Bergen, Norway. dag.moster@smis.uib.no

BACKGROUND: Advances in perinatal care have increased the number of premature babies who survive. There are concerns, however, about the ability of these children to cope with the demands of adulthood. **METHODS:** We linked compulsory national registries in Norway to identify children of different gestational-age categories who were born between 1967 and 1983 and to follow them through 2003 in

order to document medical disabilities and outcomes reflecting social performance. RESULTS: The study included 903,402 infants who were born alive and without congenital anomalies (1822 born at 23 to 27 weeks of gestation, 2805 at 28 to 30 weeks, 7424 at 31 to 33 weeks, 32,945 at 34 to 36 weeks, and 858,406 at 37 weeks or later). The proportions of infants who survived and were followed to adult life were 17.8%, 57.3%, 85.7%, 94.6%, and 96.5%, respectively. Among the survivors, the prevalence of having cerebral palsy was 0.1% for those born at term versus 9.1% for those born at 23 to 27 weeks of gestation (relative risk for birth at 23 to 27 weeks of gestation, 78.9; 95% confidence interval [CI], 56.5 to 110.0); the prevalence of having mental retardation, 0.4% versus 4.4% (relative risk, 10.3; 95% CI, 6.2 to 17.2); and the prevalence of receiving a disability pension, 1.7% versus 10.6% (relative risk, 7.5; 95% CI, 5.5 to 10.0). Among those who did not have medical disabilities, the gestational age at birth was associated with the education level attained, income, receipt of Social Security benefits, and the establishment of a family, but not with rates of unemployment or criminal activity. CONCLUSIONS: In this cohort of people in Norway who were born between 1967 and 1983, the risks of medical and social disabilities in adulthood increased with decreasing gestational age at birth. 2008 Massachusetts Medical Society

PMID: 18635431 [PubMed - indexed for MEDLINE]

27. Clin Perinatol. 2006 Dec;33(4):947-64; abstract xi.

Neurodevelopmental outcome of the late preterm infant.

Adams-Chapman I.

Department of Pediatrics, Division of Neonatology, Emory University School of Medicine, Atlanta, GA 30303, USA. ira_adams-chapman@oz.ped.emory.edu

There is very limited information about the developmental outcome of the late preterm infant. The developing brain is vulnerable to injury during this very active and important stage of fetal brain development; therefore, it is important to carefully monitor the neurologic outcome of these infants. This article discusses gestational brain development and complications of late preterm birth that contribute to the overall risk of brain injury.

PMID: 17148014 [PubMed - indexed for MEDLINE]

28. Pediatrics. 2009 Apr;123(4):e622-9.

Early school-age outcomes of late preterm infants.

Morse SB, Zheng H, Tang Y, Roth J.

Department of Pediatrics, University of Florida, Gainesville, FL 32610-0296, USA.
morsesb@peds.ufl.edu

OBJECTIVE: Late preterm infants represent a significant portion of preterm deliveries. Until recently, these infants have received little attention because of assumptions that they carry minimal risk for long-term morbidities. The purpose of this study was to compare prekindergarten and kindergarten outcomes among healthy late preterm infants, 34 0/7 to 36 6/7 weeks' gestation at birth, and healthy term infants, 37 0/7 to 41 6/7 weeks' gestation at birth. **METHODS:** The study sample consisted of singleton infants who were born in Florida between January 1, 1996, and August 31, 1997, with a gestational age between 34 and 41 weeks (N = 161804) with a length of stay < or =72 hours. Seven early school-age outcomes were analyzed. Outcomes were adjusted for 15 potential confounding maternal and infant variables. Unadjusted and adjusted relative risk with 95% confidence interval was estimated for each outcome by using Poisson regression modeling. **RESULTS:** Risk for developmental delay or disability was 36% higher among late preterm infants compared with term infants. Risk for suspension in kindergarten was 19% higher for late preterm infants. The remaining 4 outcomes, disability in prekindergarten at 3 and 4 years of age, exceptional student education, and retention in kindergarten, all carried a 10% to 13% increased risk among late preterm infants. The assessment "not ready to start school" was borderline significant. **CONCLUSIONS:** This study suggests that healthy late preterm infants compared with healthy term infants face a greater risk for developmental delay and school-related problems up through the first 5 years of life.

PMID: 19336353 [PubMed - indexed for MEDLINE]

29. Clin Perinatol. 2006 Dec;33(4):883-914; abstract x.

The late preterm infant and the control of breathing, sleep, and brainstem development: a review.

Darnall RA, Ariagno RL, Kinney HC.

Department of Physiology, Dartmouth-Hitchcock Medical Center, Lebanon, NH 03756, USA. robert.a.darnall@hitchcock.org

The brainstem development of infants born between 33 and 38 weeks' gestation is less mature than that of a full-term infant. During late gestation, there are dramatic and nonlinear developmental changes in the brainstem. This translates

into immaturity of upper airway and lung volume control, laryngeal reflexes, chemical control of breathing, and sleep mechanisms. Ten percent of late preterm infants have significant apnea of prematurity and they frequently have delays in establishing coordination of feeding and breathing. Unfortunately, there is a paucity of clinical, physiologic, neuroanatomic, and neurochemical data in this specific group of infants. Research focused on this group of infants will not only further our understanding of brainstem maturation during this high risk period, but will help develop focused plans for their management.

PMID: 17148011 [PubMed - indexed for MEDLINE]

30. J Pediatr. 2007 Nov;151(5):450-6, 456.e1. Epub 2007 Jul 24.

Differences in mortality between late-preterm and term singleton infants in the United States, 1995-2002.

Tomashek KM, Shapiro-Mendoza CK, Davidoff MJ, Petrini JR.

Maternal and Infant Health Branch, Division of Reproductive Health, Centers for Disease Control and Prevention, Atlanta, Georgia, USA. kct9@cdc.gov

Comment in:

J Pediatr. 2007 Nov;151(5):445-6.

OBJECTIVE: To assess differences in mortality between late-preterm (34-36 weeks) and term (37-41 weeks) infants. **STUDY DESIGN:** We used US period-linked birth/infant death files for 1995 to 2002 to compare overall and cause-specific early-neonatal, late-neonatal, postneonatal, and infant mortality rates between singleton late-preterm infants and term infants. **RESULTS:** Significant declines in mortality rates were observed for late-preterm and term infants at all age-at-death categories, except the late-neonatal period. Despite the decline in rates since 1995, infant mortality rates in 2002 were 3 times higher in late-preterm infants than term infants (7.9 versus 2.4 deaths per 1000 live births); early, late, and postneonatal rates were 6, 3, and 2 times higher, respectively. During infancy, late-preterm infants were approximately 4 times more likely than term infants to die of congenital malformations (leading cause), newborn bacterial sepsis, and complications of placenta, cord, and membranes. Early-neonatal cause-specific mortality rates were most disparate, especially deaths caused by atelectasis, maternal complications of pregnancy, and congenital malformations. **CONCLUSIONS:** Late-preterm infants have higher mortality rates than term infants throughout infancy. Our findings may be used to guide obstetrical and pediatric decision-making.

PMID: 17961684 [PubMed - indexed for MEDLINE]